CLAIMS LISTING

1.-34. (Cancelled)

35. (New) A seal fixed between a housing and a rotating shaft comprising:

a. a stator fixed and sealingly mounted to said housing and concentrically about said shaft, said stator having opposite end faces, an exterior peripheral surface and an interior peripheral surface;

b. a first annular groove formed in said stator and extending axially between said end faces and positioned intermediate said exterior and interior peripheral surfaces, wherein said first annular groove communicates directly with said shaft and is operable to collect fluid material separated from said shaft; and,

c. at least one axial slot formed in said interior peripheral surface of said stator, wherein said at least one axial slot communicates with said first annular groove in said stator for draining fluid material collected in said first annular groove into said housing.

36. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 35 further comprising:

a. a rotor sealingly mounted to said shaft for rotation therewith and having opposite end faces, an exterior peripheral surface and an interior peripheral surface;

b. a second annular groove formed in said stator exterior end face and extending axially from said exterior end face, said second annular

groove located intermediate said stator exterior and interior peripheral surfaces;

c. a rotor annular flange formed in said rotor, said rotor annular flange extending axially from an end face of said rotor and positioned intermediate to said rotor exterior and interior peripheral surfaces, wherein said rotor annular flange is received within said second annular groove in said stator;

d. an exterior annular channel formed by engagement of said rotor and said stator for collecting contaminants entering said seal; and,

e. an external drain extending from said exterior annular channel to the exterior of said housing to expel contaminants from said exterior annular channel.

37. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 36 wherein said rotor includes means for imparting energy to contaminants entering said exterior annular channel for expulsion from said seal.

38. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 37 wherein said exterior annular channel is positioned within said rotor extending axially from one end face intermediate the exterior and interior peripheral surfaces of said rotor.

39. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 37 wherein said exterior annular channel is positioned within said

stator extending axially from one end face intermediate the exterior and interior peripheral surfaces of said stator.

40. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 37 wherein said exterior annular channel is formed by opposing grooves within said stator and said rotor, wherein said opposing grooves extend axially from one end face intermediate the exterior and interior peripheral surfaces of said stator and said rotor.

41. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 36 wherein said stator and said rotor are unitized by a unitizing ring, wherein said unitizing ring seats in a stator unitizing ring groove when said shaft is not rotating thereby sealing the interior of said seal from the exterior of said seal, wherein said unitizing ring rotates with said rotor and wherein said unitizing ring expands during rotation so that said unitizing ring seats in a rotor unitizing ring groove.

42. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 41 wherein said unitizing ring operates with no clearance between said rotor unitizing ring groove or said stator unitizing ring groove when said shaft rotates.

43. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 36 wherein the bottom of said axial slot is formed at an angle with respect to said shaft.

44. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 35 wherein the clearance between said stator and said shaft is 0.05 inches for each inch of shaft diameter.

45. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 35 further comprising a plurality of axial slots, wherein the circumferential periphery of said first annular groove in said stator bisects each individual slot of said plurality of axial slots and wherein adjacent axial slots are spaced so that a line connecting the center of one axial slot to the center of the adjacent axial slot does not intersect the interface between said stator and said shaft.

46. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 35 wherein said first annular groove is formed as a plurality of annular grooves formed in said stator and extending axially between said end faces and positioned intermediate said exterior and interior peripheral surfaces, wherein said plurality of annular grooves communicate directly with said shaft and are operable to collect fluid material separated from said shaft.

47. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 35 wherein said first annular groove is comprised of a plurality of annular grooves formed in said stator and extending axially between said end faces and positioned intermediate said exterior and interior peripheral surfaces, wherein said plurality of annular grooves communicate directly

with said shaft and are operable to collect fluid material separated from said shaft.

48. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 47 further comprising:

a. a rotor sealingly mounted to said shaft for rotation therewith and having opposite end faces, an exterior peripheral surface and an interior peripheral surface;

b. a second annular groove formed in said stator exterior end face and extending axially from said exterior end face, said second annular groove located intermediate said stator exterior and interior peripheral surfaces;

c. a rotor annular flange formed in said rotor, said rotor annular flange extending axially from an end face of said rotor and positioned intermediate to said rotor exterior and interior peripheral surfaces, wherein said rotor annular flange is received within said second annular groove in said stator;

d. an exterior annular channel formed by engagement of said rotor and said stator for collecting contaminants entering said seal; and,

e. an exterior drain extending from said exterior annular channel to the exterior of said housing to expel contaminants from said exterior annular channel.

49. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 48 wherein said rotor includes means for imparting energy to contaminants entering said exterior annular channel for expulsion from said seal.

50. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 48 wherein said exterior annular channel is positioned within said rotor extending axially from one end face intermediate the exterior and interior peripheral surfaces of said rotor.

51. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 48 wherein said exterior annular channel is positioned within said stator extending axially from one end face intermediate the exterior and interior peripheral surfaces of said stator.

52. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 48 wherein said exterior annular channel is formed by opposing grooves within said stator and said rotor, wherein said opposing grooves extend axially from one end face intermediate the exterior and interior peripheral surfaces of said stator and said rotor.

53. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 48 wherein said stator and said rotor are unitized by a unitizing ring, wherein said unitizing ring seats in a stator unitizing ring groove when said shaft is not rotating thereby sealing the interior of said seal from the exterior of said seal, wherein said unitizing ring rotates with said

rotor and wherein said unitizing ring expands during rotation so that said unitizing ring seats in a rotor unitizing ring groove.

54. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 53 wherein said unitizing ring operates with no clearance between said rotor unitizing ring groove or said stator unitizing ring groove when said shaft rotates.

55. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 48 wherein the bottom of said axial slot is formed at an angle with respect to said shaft.

56. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 47 wherein the clearance between said stator and said shaft is 0.05 inches for each inch of shaft diameter.

57. (New) The seal fixed between a housing and a rotating shaft as set forth in claim 47 further comprising a plurality of axial slots, wherein the circumferential periphery of said first annular groove in said stator bisects each individual slot of said plurality of axial slots and wherein adjacent axial slots are spaced so that a line connecting the center of one axial slot to the center of the adjacent axial slot does not intersect the interface between said stator and said shaft.

SUBSTITUTE SECTION (CLEAN COPY)

DESCRIPTION OF THE PREFERRED EMBODIMENT

Element Description	Element Number
Ramped Shoulder	1
Rotor Inner Peripheral Surface	2
Stator Interior End Face	3
Stator Exterior End Face	4
Stator Outer Peripheral Surface	5
Stator Interior Peripheral Surface	6
Stator Unitizing Ring Groove	7
Rotor Unitizing Ring Groove	8
First Rotor/Stator Interface	9
Second Stator Annular Groove (Transverse to Shaft)	10
Seal	11
Rotor	12
Stator	13
Housing	14
Shaft	15
Bearing	16
Rotor Annular Flange	17
Stator O-ring	18
Stator Annular "Deep" Groove	19
Inside Groove Sidewall	19a
Outside Groove Sidewall	19b
First Stator/Shaft Clearance Face	19c
Second Stator/Shaft Clearance Face	19d
Peripheral Groove Surface	19e
Axial Slot	20
Trough	20a
Unitizing Ring	21
Rotor Exterior End Face	22
Rotor O-ring	23
External Drain	24
Annular Stator Flange	25
First Annular Rotor Groove	26
Stator O-ring Groove	27
Rotor O-ring Groove	28
Second Annular Rotor Groove	29
Lubricant Sump	30
Exterior Annular Channel	31
Circumferential Channel Surface	32
Stator Outer Peripheral Groove	33
Linear Radial Interface	34
Vertical Interface	35
Second Rotor/Stator Interface	36

[15] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, FIG. 1 shows a seal 11 mounted in a housing 14 having a bearing 16 with a rotatable shaft 15 there-through. In applications where there is no risk of external contaminants entering the seal 11, the stator 13 alone is sufficient for lubricant retention and no rotor 12 is required. In the embodiment shown in FIGS. 1, 3 and 4, the stator 13 has opposite end faces, an interior end face 3 and an exterior end face 4, a first stator/shaft clearance face 19c (forming a portion of the inner periphery of the stator 13), a second stator/shaft clearance face 19d (forming another portion of the inner periphery of the stator 13), an interior peripheral surface 6, and an outer peripheral surface 5 with a ramped shoulder 1.

[16] There may be more than one stator annular groove 19 (also referred to as a "Deep Groove"), however all material limitations must be observed with a plurality of grooves i.e., the radial cross section and material characteristics must still be limiting factors as to the depth and width of the stator annular groove 19. The opening of the stator annular (deep) groove 19 must be positioned to face the shaft 15.

[17] As is best seen in FIG. 3 (a view of the stator 13 with no rotor 12 present), the stator 13 has a stator O-ring groove 27 in which a stator O-ring 18 is mounted for a frictional, gasketed fit within housing 14. In this embodiment a ramped shoulder 1 in the stator 13 limits the inward axially movement of the stator 13 with respect to the housing 14. The stator 13 is formed with an annular "deep" groove 19 that in both the axial and radial dimensions is as large as physically practicable and allowed by the dimension and application of the seal 11. Stator annular "deep" groove 19 is defined by the inside groove sidewall 19a, outside groove sidewall 19b and the peripheral groove surface 19e. The stator annular "deep" groove 19 is in communication with the shaft 15 via the first stator/shaft

clearance face 19c and the second stator/shaft clearance face 19d. When the shaft 15 rotates, it imparts kinetic energy to any lubricant that is on the shaft 15. Consequently, the lubricant on shaft 15 is flung from the shaft 15 and collected in the stator annular "deep" groove 19. Axial slot 20 is in communication with the stator annular "deep" groove 19 as shown in FIG. 2. In one embodiment, the axial slot 20 is an elongated hole (as shown in FIG. 2) in the stator interior end face 3, with a trough 20a forming the bottom surface. The stator 13 is situated within the housing 14 so that the axial slot 20 is in the gravitationally lowest position so that lubricant collected in the stator annular "deep" groove 19 will flow by gravity through axial slot 20. Axial slot 20 drains to a lubricant sump 30 in the housing 14 so that lubricant collected in the stator annular "deep" groove 19 is retained within the housing 14. The design of the stator annular "deep" groove 19 in the stator 13 being in direct communication with the shaft 15, with no rotor between said stator annular "deep" groove 19 and said shaft 15, provides for excellent lubricant retention in situations where a typical rotor/stator type seal 11 would have a propensity to leak, such as: unusually high lubricant levels, high lubricant turbulence caused by a cylindrical roller, meshing gears or similar bearings in which lubricant has a tendency to impinge on the trough 20a or applications using plain or sleeve bearings (especially when pressure lubricated) in which the lubricant has a tendency to travel parallel to the shaft 15 and cause an external leak. A stator 13 may be fashioned with a plurality of annular "deep" grooves 19 in the axial dimension if such a configuration would yield superior lubricant retention in the desired application for the seal 11.

[18] In the embodiment shown in FIG. 5, the stator 13 is fashioned with a plurality of axial slots 20 that are circular in shape. In this embodiment, the stator 13 may be rotated within the housing 14 while continually having a gravitationally low axial slot 20 available, making this embodiment particularly useful in applications in which the housing 14 of a rotating machine must be

rotated to correct for the axial position of the shaft 15. The peripheral groove surface 19e intersects the axial slots 20 so as to bisect the axial slots 20. In this embodiment, the axial slots 20 are positioned so that a line from the center of one axial slot 20 to the center of one adjacent axial slot 20 will not intersect the first stator/shaft clearance face 19c. In this way, in any orientation of the stator 13 about the housing 14, one of the axial slots 20 will be the gravitationally lowest point, so as to facilitate gravity draining of lubricant collected in the stator annular "deep" groove 19. Typically, axial slot 20 is as far away from shaft 15 and the stator 13 interface as possible.

[19] In applications where there is a possibility for external contaminants to enter the seal 11, a rotor 12 (as shown in FIGS. 1 and 4) is often employed in the seal 11 assembly. The rotor 12 has a rotor inner peripheral surface 2 in which a rotor O-ring groove 28 is formed. A rotor O-ring 23 is mounted in the rotor O-ring groove 28 to frictionally and sealingly mount the rotor 12 on the shaft 15 so that the rotor 12 rotates with the shaft 15. In this embodiment, the stator 13 functions in the same manner and is mounted within the housing 14 in the same manner as in the previously described embodiment employing only a stator 13. That is to say, even when a rotor 12 is included in the seal 11, the stator annular "deep" groove 19 in the stator 13 is in direct communication with the shaft 15. However, in this embodiment, the stator 13 also includes an annular stator flange 25 that corresponds to a first annular rotor groove 26, and a second stator annular groove 10, with an opening transverse to shaft 15, that corresponds to a rotor annular flange 17, all of which cooperate to form a labyrinth seal within the stator 13 and the rotor 12 to help seal the bearing 16 from external contaminants.

[20] The rotor 12 and the stator 13 are unitized by a unitizing ring 21. The unitizing ring 21 seats within the stator unitizing ring groove 7 when the shaft 15 is not rotating (depicted in the embodiment shown in FIG. 1) and thereby seals

the second rotor/stator interface 36 and second stator/shaft clearance face 19d, and consequently the stator annular "deep" groove 19, first stator/shaft clearance face 19c, the lubricant sump 30 and bearing 16 from the exterior annular channel 31 (which channel is described in detail below), the first rotor/stator interface 9 and the external environment. This sealing function is especially useful when the shaft 15 has been rotating and the housing 14, bearing 16 and the seal 11 are at a higher than ambient temperature and subsequent cooling as a result of non-rotation of the shaft 15 causes the housing 14, bearing 16 and the seal 11 to cool and create a vacuum effect with the external environment. If the unitizing ring did not achieve the sealing function described above, the resulting pressure gradient would induce external contaminants to pass into the first rotor/stator interface 9 and from there into the seal 11 and the bearing 16, which contributes to premature bearing 16 failure. When the shaft 15 rotates the unitizing ring 21 also rotates, causing the unitizing ring 21 to expand radially and seat in the rotor unitizing ring groove 8. In this state, the unitizing ring 21 runs with no clearance with either the stator unitizing ring groove 7 or the rotor unitizing ring groove 8.

[21] The rotor 12 and/or the stator 13 may be fashioned with an exterior annular channel 31 for collecting external contaminants that have passed through the first rotor/stator interface 9. FIG. 1 shows only the rotor 12 fashioned with an exterior annular channel 31, although a corresponding exterior annular channel 31 could be fashioned in the stator 13 in the presence or absence of the exterior annular channel 31 fashioned in the rotor 12. The exterior annular channel 31 communicates with the first rotor/stator interface 9 and the interface between the rotor annular flange 17 and the second stator annular groove 10. External contaminants from both the first rotor/stator interface 9 and the interface between the rotor annular flange 17 and the second stator annular groove 10 are collected in the exterior annular channel 31. Centrifugal force imparted to

external contaminants from the rotation of the rotor 12 causes the external contaminants to migrate onto the circumferential channel surface 32. An external drain 24 is positioned at the gravitationally lowest point of the stator 13 and communicates with the exterior annular channel 31 so that external contaminants in the exterior annular channel 31 drain by gravity through the external drain 24 and out of the seal 11. The contaminant expulsion is not assured when rotation of this seal 11 occurs. However, this invention provides that in one configuration the diameter at interface of rotor 12 with stator 13 is greater than the diameter of stator 13. This differential creates a pumping action of contaminants outwardly at the rotor/stator interface because of ever increasing diameter in the direction of the intended path of contaminants expulsion and exclusion.

[22] FIG. 4 provides another embodiment of the present invention. In the embodiment shown in FIG. 4, there is no external drain 24 fashioned in the stator 13. In this embodiment, the stator 13 includes a stator outer peripheral groove 33, the exterior wall of which is formed by a linear radial interface 34 between the stator 13 and the rotor 12, which is accomplished by extension in the radial direction of the annular stator flange 25, and consequently a similar extension of the first annular rotor groove 26. The lubricant retention function of this embodiment is substantially the same as that in the previous embodiments. However, in the embodiment shown in FIG. 4, the linear radial interface 34 between the stator 13 and the rotor 12 provides for a superior ability of the seal 11 to prevent entry of external contaminants into the first rotor/stator interface 9. In this embodiment, external contaminants entering the stator outer peripheral groove 33 are not prone to enter the first rotor/stator interface 9 due to the vertical interface 35 between the rotor 12 and the stator 13 and the centrifugal pumping action associated with the vertical interface 35 when the rotor 12 is rotating.